

‘That’s not the way I was taught science at school!’ How Pre-service Primary Teachers in Abu Dhabi, United Arab Emirates are affected by their own Schooling Experiences

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ABSTRACT: Government schools in Abu Dhabi, as part of widescale educational reforms undertaken in the whole of the United Arab Emirates (UAE), have undergone significant change since 2007 across cycles and across subjects including science. Science had been taught historically in the UAE using fairly traditional ‘chalk and talk’, teacher-centered approaches. Nowadays, schools under Abu Dhabi Educational Council (ADEC) favour a modern approach towards teaching science, with new teachers being required to be proficient in teaching science skills such as inquiry-based learning in order to implement the curriculum effectively. However, there is a wide body of literature research to suggest that pre-service teachers hold beliefs about science education embedded from their own experience prior to their teacher-training, particularly from their own schooling experience, which can be difficult to overturn. In a didactic schooling system, Emirati pre-service teachers may have had few role models of the kind of teacher they will be required to be when they take up a post with ADEC upon graduation. We explored the schooling experiences of the first and fourth year pre-service teachers in our training college, comparing their teaching and learning experiences for differences due to the reforms in the UAE, and explored the ways in which these experiences may influence kind of science teacher they will become.

KEY WORDS: Pre-service science teachers, prior schooling, science education, inquiry-based learning

BACKGROUND

Pre-Service Teachers’ Beliefs

Although teacher educators sometimes speak of pre-service teacher education as the first stage in learning to teach, nothing could be further from the truth. In fact, before they take their first professional course, future teachers have already observed thousands of hours of teaching which has instilled traditional images of teaching and learning but also

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has shaped their understanding of a subject (Ball, 1989, p.1). An issue for pre-service teachers (PSTs) in the United Arab Emirates (UAE) is that the observation of at least some of these ‘thousands of hours of teaching’ may have been of inadequately trained teachers. Due to the dearth of national teachers, up until 2009 many school teachers had to be recruited from non-Gulf Arab countries such as Egypt, Jordan or Syria. The pedagogical backgrounds of such teachers has been called into question by some researchers, since some did not hold professional teaching qualifications, or their teacher education often encompassed little or no hands-on teaching experience (Barber et al, 2007, Ridge, 2010).

Kagan (1992) found that personal beliefs of PSTs about teaching did not significantly change during their teacher education. When they entered their teacher-training program they brought with them beliefs and images about themselves as teachers, and memories of learning in the classroom from their own prior schooling experiences. In contrast to this, a study by Ucar (2012) found that teacher training courses did change beliefs regarding teaching science, but not of science and scientists. Ball (1990) postulated that even if pre-service teachers do not understand what they learned, they will reproduce instruction in the same manner in which they learned it, unless they are challenged to become better. Swars, Hart, Smith, Smith, & Tolar (2007) found that PSTs’ beliefs are malleable only during formal schooling and through the first few years of teaching. In this case, “the earlier pre-service teachers’ negative beliefs are challenged, the more time there is to modify them in a way that will adequately prepare them for successful experiences in their future classrooms” (Hunt-Ruiz, 2011, p 86). Chambers et al (2002) discovered that some students leave initial teacher education because of a mismatch between the expectations and reality they experienced during education.

There is a general consensus in the literature that beliefs play an important role in PSTs’ views of learning and teaching (Richardson, 1996). Irez (2006) reflected on the critical role played by teacher educators, saying that “it is clear that if science teachers are to improve their own conceptions, then it is surely the teacher educators’ role to facilitate effective curriculum planning and delivery, including the development of appropriate teaching strategies” (p 115). It is well known that teachers’ self-efficacy in science teaching correlates with their use of particular science teaching strategies. This is particularly true of more complex, higher level teaching skills such as the application of science concepts to new situations and inquiry-based learning. By contrast, teachers with high self-efficacy in science are seen to use student-centred teaching strategies such as inquiry based instruction (Fitzgerald, Dawson & Hackling, 2008).

Furthermore, studies have shown that students generally learn more from teachers with high self-efficacy than from teachers with low self-

efficacy (Ashton and Webb, 1986). Many science educators believe that engaging students in authentic scientific inquiry is key to scientific literacy (Hume, 2009). It is “critical that teachers understand and appreciate what authentic inquiry involves” (p 35). These are critical skills which students need to have frequent exposure to in science lessons in order to master, but in order to have this exposure, their teachers need to be confident about teaching them. It is clear, then, that the beliefs and attitudes of pre-service teachers are of great importance in determining the likelihood of them becoming effective teachers. These teachers must be capable of implementing the New School Model in the way which it was intended, and in the way which is needed to up-skill young Emirati school students to become independent, critical thinkers in science.

Educational Reform in Abu Dhabi, United Arab Emirates

In 2006, a wide-scale educational reform began in Abu Dhabi initially in Cycle 1 (Grades 1-5) schools under the auspices of Abu Dhabi Educational Council (ADEC). A new curriculum for science, adopted from the Australian New South Wales curriculum, was drafted in 2007-2008 and gradually implemented into schools. Schools were attended by advisors, whose remit was to provide professional development to schools in order to improve pedagogy and encourage best practice within the classroom such as student-centred learning, etc. This was in contrast to the “teacher dominated, heavily transmitted teaching styles which were commonplace in schools until that time” (Shaw, Badri and Hukul, 1995, p.12), based on memorizing facts and regurgitation (Sonleitner & Khelifa, 2005). Macpherson, Kachelhoffer and El Nemr (2007) discussed the pre-reform curriculum being “traditional, repetitive, [with] fragmented and redundant content, disconnected from community and national needs” and that “rote learning was preventing the interaction needed to develop research, analysis and communication skills required for higher learning (Al Ittihad, 2005, p 8-9, in Macperson, Kachelhoffer and El Nemr, 2007). Gaad, Arif and Scott (2006), upon examining the education system prior to 2006, concluded that there was poor alignment among what the system was developed for and how it was delivered.

The new curriculum that was introduced emphasized critical thinking rather than rote learning (Davidson, 2010). In 2009, ADEC began to employ thousands of English medium teachers from countries such as U.S.A., Canada, U.K., Australia and New Zealand. These EMTs would take over, as generalists, the teaching of the English medium subjects of Maths, Science and English in Cycle 1 schools using the ‘New School Model’ adopted by ADEC, and the teaching of English in Cycle 3 (Grades 10-12). In addition to the new science content of the curriculum, there was a much greater emphasis on science skills which teachers had to be proficient in teaching. In Cycle 3 schools, although the curriculum for

science education remained the same, from 2008 advisers in that cycle were providing professional development to teachers. They provided training in best practice in science pedagogy, observing lessons and modelling student-centred strategies, inquiry based learning and exploratory learning, so some Cycle 3 teachers may have begun to change their long-held beliefs and practices based on this.

The goals of ADEC's ambitious ten year Strategic Plan (2009-2018) were many, and included Abu Dhabi public school students performing above international average and that all school-age children would have access to quality schools. The vehicle for this success would be the New School Model (NSM), some of the key elements of which were the "standardization of curriculum, pedagogy, resources and support across all ADEC school types" and that students would be encouraged to "develop critical thinking skills, and cultural and national identity through the consistent use of rigorous learning outcomes and pedagogy" (ADEC New School Model Documentation, 2009, p.2).

RATIONALE

The PSTs at the teacher-training college where this research took place graduated from high school four years apart, in approximately 2007/2008 and 2011/2012 for fourth and first year students respectively. Given what is known about the educational system in the UAE prior to, and in the early days of, the educational reform, we wished to explore the possible differences in the PSTs' schooling experiences, postulating that the fourth year PSTs may have had a less hands-on experience of learning science than the first year PSTs. Based on the earlier picture of Cycle 3 schools in the UAE prior to 2008 (and obviously, for some period after this too), it would not seem likely that fourth year students were exposed to higher level skills such as inquiry, and perhaps not many hands-on experiential learning approaches either. This would be significant, because there is some research to support the idea that science teachers often teach science the way that they themselves were taught as students, regardless of the content or quality of the teacher training they received (e.g. Adams and Krockover, 1997). Research evidence suggests that PSTs have their own beliefs about science education embedded from their own prior experience as, which for some may not have been in fitting with ADEC's vision of the way in which science should ideally be taught. We also explored the kind of science teachers which the students anticipate becoming, their confidence in teaching particular science skills, and looked at correlations between the way they were taught and they way they plan to teach.

Some researchers note that education courses have a limited effect on over-riding poor pedagogical practices experienced during their own

schooling, and that everything students learn on teacher-training courses is viewed and received through a filter of their own schooling experience. This makes it even more important for teacher-training colleges, and educational councils, to be aware of the impact schooling may have had on pre-service, novice and even experienced teachers, and the possible repercussions of this to students. There is growing consensus that teachers play a paramount role in bringing about significant and meaningful improvements in the education of children. In the USA, despite the reform-based standards, and altered benchmarks, “classrooms of many teachers display instructional practices that do not support their stated beliefs or their teacher preparation experiences with reform or inquiry-based science instruction” (Soldat, 2009, p 6). Simply altering curriculum without changing beliefs will not result in altered practice, and it is critical for educational researchers to understand more about this gap between teacher beliefs and their practice during their pre-service programs. Therefore, the research has novelty and value, both on a college level and nationally. To our knowledge, there is a complete absence of such research in the Gulf and certainly none specific to the unique reform context of the UAE, a country which is rapidly developing its education systems. It will be of interest internationally to other countries undergoing educational reform who are trying to train science teachers to teach in a manner which may be radically different in the way that they themselves learned as students.

RESEARCH QUESTIONS

1. What were the school experiences (as students) of the first and fourth year PSTs?
2. Are these significantly different between the two year groups?
3. How do PSTs at ECAE anticipate that they themselves will teach science in the future, and in particular, how confident do the PSTs feel about teaching science skills?

METHODOLOGY

Participants

The 85 participants involved in this study were first and fourth year undergraduate students at a teacher training college, studying on a four-year Bachelor of Education program. Since this particular research was part of a wider study looking at various aspects of the teacher-training program, we included all year groups in the study to enable comparisons of particular year groups, but for the purposes of this article we report the findings of the first and fourth year groups to enable us to compare

perceptions and schooling experiences between these groups. The data was collected at the beginning of the second semester, prior to the fourth year PSTs embarking on their final and major ten week school internship.

Data Collection Instrument

The instrument used for data collection was a survey questionnaire, with questions presented in both English and Arabic for ease of comprehension. They were reviewed by two objective pre-viewers who gave feedback on the relevance of the survey questions to the research questions; adjustments were made on the basis of this feedback. The survey utilised four-point Likert-scale questions (Strongly Agree, Agree, Disagree, Strongly Disagree), with opportunity for participants to add additional qualitative responses.

The survey was divided into sections as follows:

- A. Past learning experience in science (12 items)
- B. Confidence in teaching science inquiry skills (4 items)
- C. Future teaching intentions (13 items)

It was administered as a hard-copy and collected at the same time resulting in an almost 100% survey return rate of those present. The data was entered into a spreadsheet and Excel Statistics Package used to produce the descriptive and correlative statistics. The established protocols for undertaking quantitative research of this nature were followed: participants were briefed as to the purpose and procedure of the survey questionnaire, and informed consent obtained.

FINDINGS AND CONCLUSIONS

What were the schooling experiences of the first and fourth year PSTs?

We asked the PSTs to rate their agreement with a series of statements relating to their own experiences of learning science as school students (we were not specific about a particular schooling cycles, but only their overall perceptions), trying to develop a picture of the types of learning strategies they had, or had not, been exposed to (Table 1).

Both groups were in fairly high agreement (74 and 77% of first and fourth year PSTs respectively) that their science teacher "always demonstrated practical experiments to us before we began" (A12). Whilst this was to be expected during the time of the fourth year PSTs' schooling, it may be a little surprising that this habit was still prevailing at the time of the first year PSTs' schooling. This could, of course, be a reference to earlier years of their schooling, or perhaps of those teachers who were resistant to the new teaching strategies being encouraged. Either

Table 1: The PSTs' experience of learning science during their own schooling

<i>Statement about the way the PSTs learned science</i>	<i>First Years (n=40)</i>	<i>Fourth Years (n=45)</i>	<i>t-test (2-tailed, unpaired)</i>
	<i>% Agree/Strongly Agree</i>	<i>% Agree/Strongly Agree</i>	
A1. I was actively involved in the learning process in my science classes.	78	81	0.351 (ns)
A2. In my science class I used a journal to reflect and record my findings.	72	39	0.005 (s) $p \leq 0.05$
A3. In my science class I was given opportunities to reflect on what I had learned.	76	71	0.623 (ns)
A4. I was frequently engaged in hands-on practical work.	68	62	0.956 (ns)
A5. In my science class I learned inquiry skills.	84	62	0.568 (ns)
A6. I had opportunities to carry out scientific inquiries	64	54	0.702 (ns)
A7. I worked with other students in cooperative learning groups.	92	78	0.866 (ns)
A8. I used, in addition to the textbook, the library and other ICT tools as learning resources..	74	53	0.159 (ns)
A9. We went on different field trips that were useful to our process of learning science.	46	29	0.736 (ns)
A10. My science teacher used a variety of assessment tools in addition to projects and examinations.	72	51	0.115 (ns)
A11. I was given opportunities to micro-teach (peer teach).	57	49	0.823 (ns)
A12. My science teacher always demonstrated practical experiments to us before we began.	74	77	0.386 (ns)

way, it is highly suggestive that many of these PSTs were still taught by fairly didactic methods in science. Student t-tests run between the first and fourth year PSTs' responses were not significant, apart from for the use of a science journal to reflect and record findings (A2) ($p = 0.05$). However, examination of the percentages between the groups' responses indicate some trends in differences. Only 29 % of fourth years remembered being taken on field trips connected to their science lessons

(A9), compared to 46 % of first years, suggesting that this may have begun to be more commonplace by that time.

Statement A3 'in my science class I was given opportunities to reflect on what I had learned' for both groups scored similar means for both groups (71, 65 % first v fourth years). This is important, according to Abd-El Khalik (2004, p 403): "Teachers need to explicitly address the reform-based goals related to knowledge about inquiry ... this end is best accomplished by having students perform scientific investigations followed by reflection on these activities ... indeed, allowing students to come to the desired understandings on their own with the aid of carefully crafted experiences and reflective questions is a much more effective approach". Significantly, 84 % of the first years said that they had learned inquiry skills in their science lessons, compared with only 62 % of the fourth years. However, when asked whether they had opportunity to carry out a scientific inquiry, these figures dropped to 64 and 54 % (first and fourth years respectively).

It is interesting that despite this, 81 % of the fourth years felt that they were 'actively involved in their science class' leading us to question their concept of 'actively involved'. The first year responses are repeatedly higher than the fourth years, and whilst the sample sizes are admittedly small and we are wary of over-generalising, it may be that this is some indication of the changes which were occurring in the government schools over the four-year period of difference. This is observed further in higher means and percentages for such statements as 'I worked with other students in cooperative learning groups' (A7), 'I used, in addition to the textbook, the library and other ICT tools as learning resources' (A8) and 'My science teacher used a variety of assessment tools in addition to projects and examinations' (A10), all of which are suggestive of a more student-centred environment in schools. A similar number of first year and fourth PSTs agreed that in science class they were frequently engaged in hands-on practical work (A4) (68 v 62 %, first v fourth years). Neither percentage is particularly high, and placing the fourth year PSTs' responses within the context of what is known about science classrooms at the time, it may be that the interpretation of 'engagement in hands-on practical work' was problematic, since perhaps even observations of the teacher carrying out practical work were included in this. Discrepancies may also arise due to the fact that most, but not all government schools in Abu Dhabi were provided with advisers whose role was to guide teachers and help them develop effective teaching strategies. Additionally, some variability between teachers is to be expected due to the inevitable resistance in educational reform. The PSTs had the opportunity to add additional qualitative comments to their survey responses. Interestingly, comments were added by first year PSTs only, and most were highly

critical of their teaching and learning experience at school and at what they perceived to be dominantly teacher-centred practices:

My science teachers were not able to develop our thinking skills as they were only explaining to us the scientific concepts and there was no time for experiments and activities.

Not enough practical activities.

We used to go sometimes to the lab but most of the time we were just looking at the teacher's work.

No hands-on activities and we were only memorizing and no field trips that encourage learning.

In one sense, the critique of their teachers' use of didactic methods ("most of the time we were just looking at the teacher's work" and "they were only explaining to us the scientific concepts and there was no time for experiments and activities") is a positive finding, since they are apparently aware that these approaches are not considered good pedagogical practices any longer. PSTs who, upon reflection of their own schooling experience, feel that the way they were taught was not ideal, may aspire to teach differently. However, "even if prospective teachers are critical of their own past teachers for teaching badly ... many of them lack alternative images of teaching, having had no other models" (Ball, 1989, p. 3). Perhaps one of the things which teacher training colleges can do is to provide positive teaching role models very early on, so that this void can be positively filled. This is true even on science knowledge courses, which many teacher training colleges offer in the first year, and which may not be understood to be equally as critical as the education courses in modelling good practice for PSTs.

Which areas of the science skills curriculum are the PSTs most confident and comfortable with?

We asked the PSTs to rate their confidence in a range of science skills (Table 2), focusing on confidence in teaching inquiry skills and higher order skills of evaluation, since these are generally most challenging for PSTs, and because student competency in inquiry-based learning is repeatedly emphasised as being desirable by the international science education community, as having a deep impact on students' ability to think critically. This was important, since as discussed, research tells us that how confident teachers feel about their abilities to teach particular areas of science curricula has a direct bearing on their teaching of those particular areas. We also wanted to assess possible links between

the confidence of the first and fourth year PSTs, and their expressed schooling experience with this type of learning.

Table 2: The confidence in which PSTs perceive that they will be able to teach certain science skills

		First Year <i>n=40</i>	Fourth Years <i>n=45</i>
		<i>% who agreed or strongly agreed they felt confident to teach this skill</i>	<i>% who agreed or strongly agreed they felt confident to teach this skill</i>
SKILLS	B1. Inquiry skills: Making predictions, planning and procedures	63	42
	B2. Inquiry Skills: Fair testing and controlling certain variables	63	60
	B3. Inquiry Skills: Recording results and writing conclusions	67	74
	B4. Inquiry Skills: Evaluation, repeatability, reproducibility of experiments	59	76

Confidence levels in skills relating to fair-testing, recording results and drawing conclusions (statements B2 and B3) were similar for the first and fourth year PSTs, and not particularly high. The first years had been exposed to one semester of courses at the time of survey, where these skills had been covered to some degree, but not extensively. The fourth year groups, however, had been given opportunities to carry out and practice such skills in four of their six science courses taken throughout the four year degree, as well as possibly being exposed to these on their school practicum experience. It is a little surprising, therefore to see that only 60 % said that they were confident (either agreeing, or strongly agreeing with the statement). This may relate to the fact that only 62 % of the fourth years said that they had learned any form of inquiry skill during their own schooling, and only 54 % had opportunity to carry out a science inquiry. More difficult to explain is that, while 84 % of first years said they had been exposed to inquiry skills at school, only 63 % felt confident about fair-testing. It may be that they struggled to apply what was observed in school with the inquiry skills taught on their college course, and of course we do not know the way in which the inquiry skills were taught at school; our question was not specific enough to decipher whether this was again observation, or actually taking part in an inquiry, and if so, which type. Fourth year PSTs are apparently more confident

than first years at evaluating experiments, possibly due to a recent exposure to this skill in a science pedagogy course, and of course their exposure to various science experiments whilst on second and third year teaching practicum.

Only 42 % of the fourth year students expressed confidence in the skills of making predictions and planning for inquiries (B1), compared with 63 % of first years. The first years' higher confidence levels may be explained by the fact that they had lately undertaken a science knowledge course which emphasized these skills, (although the confidence is still not particularly high). Again, given the repeated exposure to these skills on the science knowledge, science pedagogy courses, and practicum experience, why is the fourth year confidence so low for these particular skills? It may be suggestive of the earlier ideas ingrained from their schooling experience, and lack of opportunity to carry out inquiries then. It is of concern because of the earlier research discussed which shows that lack of confidence in skills can be directly related to teachers' coverage of such strategies in their lessons, which are sorely needed to effectively implement the new curriculum and up-skill Emirati school students. "Teachers need to be well versed in scientific inquiry as a teaching approach ... [and] in addition, teachers need to develop those pedagogical skills necessary to effectively teach about inquiry" (Abd-El-Khalik et al, 2004, p 404). Clearly, the teacher-training courses have not been effective enough to over-turn these beliefs, in the case of the fourth years, and follow-up study of the first year PSTs would be needed to see if this is the case for them too. The application of skills, too, may need practice, as even understanding ideas in theory may not help when faced with new school situations and unfamiliar experiments.

How do the PSTs anticipate that they will teach science in the future?

The PSTs were asked to rate their agreement with statements regarding their eventual teaching practices to explore the type of science teacher they perceive they are likely to become (Table 3). Whilst we are aware of the limitations of self-reported predictive data, this data does allow us to draw tentative comparisons and correlation between their own schooling experience and possible eventual practice.

For all statements except two, the first year PSTs' responses have a lower mean than the fourth years. This might suggest that teacher-training courses have been effective, for the fourth year students, in creating more positive and student-centred teaching belief systems in this regard, since most of their responses to statements have a very high mean of agreement and are suggestive of very dynamic future science teachers. Since most of the statements reflect a student-centred, hands-on approach which is mostly independent of the teacher (teacher as a facilitator), this would indicate that the first years are not entirely comfortable with the

Table 3: Mean scores of the ways in which PSTs believe that they will teach science in the future

	First Year <i>n=40</i>		Fourth Year <i>n=45</i>		t-test (2- tailed, unpaired)
	<i>Mean Scores</i>	<i>% Agree/ Strongly Agree</i>	<i>Mean Scores</i>	<i>% Agree/ Strongly Agree</i>	
C1. I will allow my students to explore and discover science concepts on their own with minimal teacher input.	3.08	76	3.44	93	0.02
C2. I will teach new science concepts to my students first, and then allow them to carry out related questions, activities and practical.	3.54	96	3.40	93	0.3
C3. I will involve students in class debates and discussions.	3.56	100	3.69	98	0.22
C4. I will actively involve students in hands-on activities and investigations.	3.54	98	3.71	98	0.1
C5. I will give my students time to record findings and reflect in their journals.	3.44	98	3.62	96	0.1
C6. I will incorporate scientific inquiry skills in my science classes.	3.50	100	3.67	98	0.1
C7. I will encourage collaborative learning among my students	3.65	100	3.80	98	0.1
C8. I think it will be important to use ICT tools in my science class.	3.63	100	3.82	98	0.1
C9. I will arrange library lessons and field trips connected to the science topics	3.54	100	3.58	93	0.7
C10. I will relate science concepts studied in class to our daily life and to the real world.	3.71	100	3.71	96	0.9

Table 3: Mean scores of the ways in which PSTs believe that they will teach science in the future (cont.)

C11. I will use different assessment tools, not only projects and exams.	3.54	96	3.62	93	0.5
C12. I will demonstrate practical work to my students first before they begin the work.	3.67	98	3.55	95	0.3
C13. I will help my students to make connections between science and other subjects.	3.54	98	3.78	96	0.028

relinquishing of teacher autonomy which a student-centred approach encompasses. This appears to contradict some of the findings in the "way in which the PSTs were taught" where they seem to reflect a slightly more student-centred environment than the fourth years, over their later years of schooling anyway.

The largest difference in percentages between the first and fourth year groups were for statements specifically referring to students learning independently of the teacher such as 'I will allow my students to explore and discover science concepts on their own with minimal teacher input'(statement C1) which showed a difference of 17%. In the previous section which looked at confidence in teaching science skills areas, the first year PSTs were most confident of all the groups about inquiry skills, which would appear to be in contradiction with the teacher-centered sentiment expressed here, but then again, it depends on the way the inquiry would actually be taught in practice. Regardless, the difference between the first and fourth year scores are suggestive that much work still needs to be done to over-turn the teacher-centered views still held by the first year PSTs which have surfaced in this data. This may not be easy - as Raven (2011, p 13) reminds us: "student-centered approaches require a whole new perspective on learning that may require substantial retraining for practitioners used to teacher-centered approaches". In order to make these changes, teachers must have a genuine desire to "foster the development of learner autonomy in the classroom" (Breen and Mann, 1997, p 146). A lower mean score for the statement 'I will allow my students to explore and discover science concepts on their own with minimal teacher input' is in contradiction to the teachings and practices of the science education courses at their teacher-training college, where allowing students to work through process-oriented guided experiments independently is strongly encouraged, suggesting that their own schooling does indeed continue to hold powerful influences over their science education belief systems.

In agreement with this finding, mean scores were higher for the first year PSTs than for the fourth year PSTs for two statements only, both of

which lean towards a teacher-centred approach, since the idea of 'teaching' a new concept first, only to repeat or reinforce with activity, rather than reach the concept through activity, is a didactic trait. These were for the statements 'I will teach new science concepts to my students first, and then allow them to carry out related questions, activities and practicals' (C2) and 'I will demonstrate practical work to my students first before they begin the work' (C12). Demonstration of a practical procedure, to be repeated by students, was commonplace in science classes in government schools, according to one experienced science education advisor (Personal Communication, 2013). Even though the fourth year PSTs were also probably frequently taught in this way as school students, their prediction that they would also demonstrate practical work for students was slightly lower, suggesting again that their teacher-training courses have had an effect on teaching belief systems.

Correlating the PSTs' experiences as school students with how they plan to teach in the future

Research would appear to be divided on the subject of how much a teacher's experience as a school student influences eventual practices. For example, as mentioned earlier, Adams and Krockover (1997) found that science teachers often teach science the way that they themselves were taught as students, regardless of the content or quality of the teacher training they received, while some researchers show a positive change in PSTs' views on science teaching over the course of their teacher-training (e.g. Ucar, 2012). If what PSTs learn on teacher-training courses is viewed and received through a filter of their own schooling experience, it is important to research whether this may or may not be true of the PSTs in the UAE too, having been educated in less than ideal environments at times. We looked at the correlation between selected statements describing the way in which the PSTs had been taught science in school, and the way they predict they will teach in the future (Table 4).

Since none of the resultant correlations were over 0.5 (or even close to 0.5) we can see that there was no statistically significant correlation between how the PSTs were taught and how they predict they will teach. Earlier we described how both groups were taught, in some ways, in fairly traditional teacher-centered approaches, and that this was more pronounced in the fourth year group, having graduated from high school four years earlier. That there is no correlation between the statements (as shown in Table 4) may be a very positive finding. For the fourth years, it could suggest that the courses and practicum experience whilst on their teacher-training courses have been very effective in over-turning schooling experiences; recall too the very high mean scores of agreement for statements of future teaching practice laid out in Table 3.

Table 4: Correlations between how the PSTs learned science in school, and how they perceive they will teach science

PSTs' experiences of learning science at school	PSTs' predictions of the way they will teach science in the future	Correlation Coefficient for these statements	
		First Year PSTs (n=40)	Fourth Year PSTs (n=45)
I was frequently engaged in hands-on practical work.	I will actively involve students in hands-on activities	-0.11	0.08
In my science class I learned inquiry skills.	I will incorporate scientific inquiry skills in my science classes.	0.15	-0.04
We went on different field trips that were useful to our process of learning science.	I will arrange library lessons and field trips connected to the science topics	0.05	-0.07
I worked with other students in collaborative learning groups	I will encourage collaborative learning among my students	0.09	0.14
In my science class I was given the opportunity to reflect on what I had learned	I will give my students time to record their findings and reflect	-0.02	0.04
My science teacher always demonstrated practical experiments to us before we began	I will demonstrate practical work to my students first before they begin the work	0.06	0.26

However, since neither the first years nor the fourth year groups show correlation between their schooling and predictions of future practice, it may not be fair to assume all of this is due to the effect of the teacher-training course. Perhaps they are a reflection of a general positivity on the part of the PSTs, who, realizing that they were not taught in the most ideal way, aspire to being better teachers. This was in fact cited as a motivating factor to teacher-training college entry for some Emirati PSTs (see Dickson, 2012) along with a desire to help their country develop as part of the educational reform.

Either way, the fact that there is no correlation between the way the PSTs were taught and the way they predict they will teach is encouraging since it suggests that they will teach in a much more effective way that they were taught themselves, using methods and strategies far from the didactic, teacher-centered approaches so prevalent in the past. The finding is also suggestive of an undertaking of reflective practice which has

enabled the PSTs to “recognize the critical link between an examination of their own beliefs and the maximization of their own teaching effectiveness” (Stuart and Thurlow, 2000).

Emirati PSTs and teachers’ ability to teach inquiry skills effectively cannot be understated in the quest to effectively implement the curriculum in the investigative manner which the reform intends. In a large review of international science education reforms which focused on six diverse countries, Abd-El-Khalik et al (2004) reiterated that extensive professional development efforts relative to inquiry are necessary and that one cannot assume that teachers already possess knowledge about inquiry, let alone an ability to teach these to their students. This study focused in part on Lebanon, with which there are some parallels with the UAE, being an Arabic-speaking country where science is taught in English to EAL students, and which has undergone numerous reforms over the past five decades. To answer the researcher’s question as to whether inquiry was being implemented in Lebanese pre-college science classrooms, first-hand observations were carried out. During the first few years following the introduction of the new curriculum, these suggested that science instruction was still traditional in nature; instruction was limited to a didactic chalk-and-talk approach. They concluded that students do not develop such understandings simply through experiencing inquiry, and that teachers needed to explicitly address inquiry by having students perform scientific investigations followed by reflection on these activities.

There are echoes of the PSTs’ schooling experience here, where many of them had been ‘taught’ inquiry skills, but far fewer had actually carried out an inquiry independently, and less than half of the fourth year PSTs expressed confidence about certain aspects of inquiry skills.

CONCLUSION

We have shown that both first and fourth year students were exposed to some teacher-centered practices over the course of their schooling. Both groups were subject to didactic practices such as repeating experiments which were first demonstrated by their science teachers. For the first year PSTs this was less so, presumably because their teachers were by then altering some of their practices as a result of the training which the educational reform encompassed. The first years, for example, were more likely than the fourth years to have been given opportunities for inquiry-based learning, to reflect on their experiences, to partake in related science field-trips, to use resources other than the textbook and to be assessed using a variety of methods. Perhaps as a result of this, the first year PSTs showed a greater confidence than the fourth years in certain areas of inquiry-based learning.

However, both groups were extremely optimistic about the kind of teachers they will become in the future, and according to their predictive statements will be extremely dynamic science teachers frequently using student-centered methodologies and encouraging independent practice such as learning science through inquiry. There was no statistical correlation between either groups' schooling experience and their predictions about the way they will teach in the future. Neither was there a significant correlation between the fourth years PSTs' confidence in their own science skills and the way they would teach in future, suggesting that, for this group at least, teacher training courses have been effective in over-turning the experiences and beliefs based on schooling. However, most research suggests that a teacher's confidence in inquiry skills is the strongest indicator of her effective classroom practice of inquiry based learning. These findings need to be followed up with the next planned part of this long-term, longitudinal study as we follow the graduates into schools next year and observe their actual science teaching practice, making comparisons between their predictions and eventual practice.

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